Ecco il calcolatore più vecchio del mondo

Sarà al centro di un convegno ad Atene l'antico calcolatore astronomico trovato nel 1901 nell'isola greca di Antikythera e risalente all'80 a.C. I resti, in rame e bronzo (foto Ansa)m componevano un congegno a orologeria che riproduceva il moto dei pianeti. (ANSA)

City 14-10-05

The Aqueduct of Samos

By Graham Inglis

The nature or use of some artifacts are pretty obvious to the archaeologists that uncover them, whilst others can still profoundly challenge the imagination of contemporary man, much to the fascination of those who are interested in ancient technology and knowledge. From time to time we find evidence that our ancestors weren't quite as dumb as we sometimes like to think they were!

While looking into the past, we gain insights into the technology and know-how available to the ancient world in two main ways - by finding their tools, and finding examples of what was achieved with those tools.

From time to time mysterious artifacts are discovered that appear to be examples of an ancient technology which challenges the accepted paradigms of history. "Antikythira's Calculator", over 2000 years old, is an astronomical instrument consisting of 30 different toothed wheels that assisted in predictions of planetary movements. The well-known "Baghdad Battery" - is another artifact that has given many in the archaeological and scientific communities pause for thought.

Our knowledge of how these tools tie in with the development of advanced structures (if indeed they ever did) is still woefully incomplete. Were ancient calculators like "Antikythira's Calculator" ever used to align stones in ancient monoliths, for example? Was the "Baghdad Battery" ever used for anything more advanced than electrolytic gold-plating of artifacts?

It is quite probable that we shall never know. However, structures whose design and construction seemingly depended upon ancient tools and/or knowledge which exist outside our current picture of ancient history have intrigued Mankind for centuries. Many ingenious theories have been propounded as to the origins and purposes of structures like Stonehenge or the Great Pyramid, for example; but one of the simplest yet most puzzling structures we know of is the Pythagorion Aqueduct on the Greek island of Samos in the Aegean Sea.

a most remarkable achievement for that era

Rediscovered in 1882 after centuries of neglect it was in a relatively good state of preservation. It is a hand-dug water-carrying tunnel that runs for over one kilometre under a limestone ridge, yet it is considered to be one of the most significant technological achievements of Greek antiquity - and here, we should not forget that the ancient Greeks achieved a good deal.

The story of the aqueduct commences over 2000 years ago, when Pythagorion, then capital city of the island of Samos, found itself with a problem with which modern sophisticated Man can symphathise: its water supply was unable to cater for its growing population. Ample supplies of water were available in the mountains to the north; however, to move the water from the mountains to the city, a 3000-foot (1 km) tunnel would have to be dug - straight through a mountain ridge known as Mt. Kastron. Nowadays, such an obstacle would be regarded as merely an administrative and technological detail to be grandly swept aside (or rather, drilled under) - but, 2500 years ago, this was a stumbling block of considerable magnitude, even to the Ancient Greeks.

Greek culture around this time was an interesting mixture of intellectual enlightenment and social and political repression Construction commenced during the tyranny of Polycrates, utilising prisoners (some captured in various inter-island wars) that were drafted in for use as slave labour. Even some intellectuals didn't find Samos a very pleasant place to live: Pythagoras, perhaps best-known for the mathematical theorem that bears his name, was born on Samos but, history relates, moved to Italy on account of Polycrates' dictatorial ruling style. However, the foundations of modern science - "classical" physical sciences, mathematics and geometry - can be traced back to those ancient Greek thinkers like Pythagoras, whose writings and other records of the time were rediscovered after the European Dark Ages and eventually led to what we now call the industrial revolution.

The Aqueduct of Samos

The Ancient Greeks considered themselves equal to the task of constructing this tunnel.

The scheme is believed to have been designed by an engineer called Eupalinos. Digging commenced in 550 B.C. and took ten years, despite the use of two working groups: the tunnellers started work from both ends at once (mainly to save time) and met in the middle with a displacement error of around twelve feet - an error of less than 0.15% of the 1035-metre tunnel's length. The Ancient Greeks were undoubtedly technologically sophisticated for their time, but this was still a most remarkable achievement for that era and their methodology has been the subject of considerable debate since its rediscovery.

The alignment of the two converging 'strands' of the Samos tunnel could well have been one of the biggest challenges the Ancient Greeks had yet faced, despite being the leaders in water ducting, since they were highly accomplished at constructing water courses of varying types. For instance, the "Archimedes Screw", which lifts water to a higher elevation by means of an internally threaded tube, dates from that era, as do the principles of water syphoning and conveying water across valleys by using bridges.

The key to the accurate construction of the water supply tunnel on Samos is most probably careful surveying and measurement – with a heavy dependence upon knowledge of triangles. Pythagoras' Theorem (which took a triangle containing a 90° angle and formalised the relationship between the other two angles and the lengths of the three sides) had yet to become a tenet of basic geometry, but the Ancient Greeks were aware of more generalised examples of the geometry of triangles, and, it is widely believed, put this knowledge to use in meticulous topographical surveying around the mountain ridge. This is basic triangulation, such as that used by mathematics students to determine the height of a tree, for example.

Eupalinos' Tunnel, as it is often known, averages 1.80 x 1.80 m in cross-section, excluding the actual water-bearing channel later dug into its floor. The one-kilometre tunnel was dug through the limestone (a fairly soft and crumbly sort of rock) by working parties using primitive-style tools - converging from opposite sides of the ridge. The excavation itself would have posed no real problems, given the availability of slaves with picks and spades. The intriguing aspect is the precision of the direction-keeping and of co-ordinating the extent to which the two digging parties progressed before unknowingly passing each other - gauging when the "it's time to link up" point had been reached would have been a considerable challenge. In an extreme scenario, had the two digging parties completely overshot, they could have ended up with two complete tunnels side-by-side, a considerable waste of time and resources!

Painstakingly careful measurement along both segments of the tunnel, and meticulous surveying techniques (using basic triangulation) seems to be the key to this particular puzzle.

In 1973, over 90 years after its rediscovery, the German Archaeological Institute of Athens undertook the task to restore the tunnel's condition and demonstrate its ability to fulfil the function for which it was designed and built more than 2500 years ago.

The most extraordinary thing about this remarkable piece of engineering is that it effectively demolishes one of the great myths of historical mathematics. The Samos aqueduct was built three hundred years before the birth of Euclid – the great mathematician and philosopher who is generally seen as the most important mathematician prior to Einstein. It appears that whereas Euclid was undoubtedly responsible for formalising a great body of Ancient Greek knowledge of geometry and mathematics he was not as revolutionary a character as has often been thought. Research has suggested that he merely collected together a number of mathematical concepts that were already known, and had been utilised widely by his forefathers. Eupalinos' Tunnel is conclusive proof that the ancient Greeks not only had a far greater knowledge of pure mathematics than is usually thought but that, possibly more important, they had a far greater knowledge of the practical applications to which these theorems could be put.

In the light of this knowledge, speculations that the ancient Greeks were capable of far greater feats of engineering, navigation and technology than is thought by most historians do not seem to be mere pipe dreams after all!